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# STUDIES ON THE SCREW WORM FLY, *CHRY SOMYIA* *MACELLARIA* FABRICIUS IN PANAMA \*

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Throughout the Canal Zone and the Republic of Panama the screw worm fly may be found in great abundance and owing to its dangerous habit of depositing its eggs in living as well as on dead tissues of man and animals, is of considerable importance economically. The number of eggs deposited in one batch by each individual fly seems to vary considerably, but when all circumstances are favorable averages 190. Of a number of batches counted by the writer the minimum deposited at one time was 48 and the maximum 287.

When ovipositing in inanimate animal substances the females seem to evince a desire to lay their egg masses all together in a heap. If a number of females are confined in a jar containing a piece of meat and one deposits her eggs, either on or near the meat, the others then oviposit either next to or on top of the mass of eggs deposited by the first female.

The eggs of a single female are laid in an irregular mass or pile, usually being placed so they overlap or rest partly on top of each other after the manner of shingles. The time required for the eggs to hatch seems to be subject to some variation. The shortest time observed was 11 hours, the longest 23 and the average about 14 hours.

Surrounding conditions seems to exert but slight influence on this incubation period as moisture and temperature are, in a certain sense, always the same in Panama. The surrounding material whether in dead carcasses, decaying vegetable tissue, or live animal tissue, is in nearly all cases of a moist nature, at least sufficiently so to keep the eggs moist. Changes in the temperature of Panama are so slight that one may disregard their influence on the incubation period of eggs deposited on inanimate material. When eggs are deposited in animate objects the body heat may tend to shorten the incubation period considerably but there has been no opportunity to verify this opinion as no tests have been made with living animals. The variations seem to be primarily due to scarcity or abundance of suitable material in which to deposit the eggs and the consequent differences in the age of the embryos at the time the eggs are deposited.

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\* From a paper read before the Medical Association of the Isthmian Canal Zone July 20, 1917, to appear in full in an early number of the Proceedings of that Association; its distribution in that form will be limited and it contains much of interest to the parasitologist. W. A. R.

The growth of the larvae is very rapid, approximately 2 mm. a day until they become mature on the fifth or sixth day. There is then a period of about 24 hours during which the larvae feed but little and after which they leave the material on which they have been feeding to seek a suitable place to pass the pupal period. Under ordinary conditions this occupies a period of from four to five days but may be shortened to three days or extended to ten. Among the emerging adults there is little disparity between the sexes. In one lot of 450 flies, 42% were females and 58% were males. Sex did not exert any appreciable influence on the length of the pupal period.

The adult flies exist on fluids or semi-fluids in material that can be reduced to a semi-liquid food. This is generally found in garbage cans, refuse heaps, or other places of like nature near habitations, and in decaying animal and plant life or other odoriferous substances in the woods or jungle away from habitations. In the Canal Zone specimens have been captured while feeding on the syrup-like fluid in the decaying flower bracts of the *Heliconia* plants.

The females appear to prefer the late afternoon or evening to deposit their eggs. This raises the question whether or not they remain active after nightfall and fly about in search of places to oviposit. Most varieties of flies became inactive at nightfall, but I have known this species to deposit its eggs during the night while in captivity, and when gravid females are captured and placed in breeding jars, they will oviposit much more readily if the jar is covered with a dark cloth than if it is left uncovered.

In Panama this fly seems to be entirely impartial in its choice of environments. It shows a preference in its breeding places in so far as the material is concerned, but if suitable places are found in town and villages, the fly will be found there as well as in the jungle. In towns they may be found flying with an angry hum about decaying material left exposed, or around a corral containing cattle. The females are very active and always on the alert, searching for either food or a place to deposit their eggs. In the jungle they are quickly attracted by any animal, probably by its odor, but perhaps also by its motion. While passing along a trail they sometimes follow and fly around one's head with a vigorous buzzing noise, undoubtedly in search of a place to deposit their eggs.

#### ATTACKS ON MAN

It is safe to say that throughout the Isthmus of Panama this fly through the agency of its larvae causes a greater amount of damage and suffering to cattle, horses and other animals, than does any other dipterous pest found there, and if one excepts the disease-bearing mosquitoes the same also applies to man as well as animals.

Eggs are deposited in the human nasal and aural cavities and in other natural openings of the body as well as in every exposed wound, ulcer, and bleeding surface. This infestation usually occurs while the victim is sleeping in some exposed place. The nasal cavity is a favorite place of attack and also the most dangerous one for the victim. In these cases the person attacked generally has recently had an attack of nose-bleed with a clot of blood remaining in the nose, or has a nasal catarrh with an offensive discharge, or a foul-smelling breath.

Sleeping in the woods or jungle, and occasionally even in unscreened houses is fraught with danger. The odor of an offensive discharge or the scent of fresh blood is very perceptible to the strong sense of smell of this fly, and if any are in the vicinity they are soon attracted to the sleeper and proceed to deposit their eggs in his nostrils. As soon as the eggs hatch and the young screw worms emerge, they begin to migrate farther into the nostrils. They tear into the mucous membranes lining the nasal cavity, feeding on the blood and serum oozing from the small wounds caused by the chitinous head hooks. They soon penetrate into the sinuses of the nasal fossae, darker and moister regions. As the young maggots begin to feed they grow rapidly as they are in ideal surroundings for growth, namely plenty of liquid food, warm temperature, and a constant supply of fresh air. Under these conditions they are very active, soon devouring the membranes lining the nasal fossae and burrowing into the surrounding muscles and cartilages. The unfortunate victim suffers at first intense irritation which soon changes to very severe pain so that he undergoes considerable suffering.

In cases of nasal myiasis one often finds a history of a nose bleed at the beginning of the disease. This leads to the conjecture that the hemorrhage precedes the infestation and that the smell of blood attracts the fly which deposits her eggs at the first opportunity easily given if the individual lies down to sleep. In the opinion of the writer this is undoubtedly the manner in which infestation takes place in a great many cases, but it is very difficult to determine this point positively. Being attracted by an odoriferous catarrhal condition the flies may also deposit their eggs in the nostrils of a person having such a condition while he is asleep. The newly hatched larvae on burrowing into the membranes may tear open small veins and capillaries and cause hemorrhage, but in such a case the laceration of the blood vessels would be so gradual that the nose bleed would be but an oozing of blood mixed with serous fluid, and unlike an ordinary case of epistaxis.

Physicians coming in contact with nasal myiasis for the first time may often be at a loss for a diagnosis of the condition, and especially in a case where the worms are in the upper cavities or have burrowed so deeply into the tissues that they are not readily discernible. This

may not be until the larvae begin either to emerge from the patient's nose or to enter the mouth through the pharynx and to be expectorated. In tropical America a bloody, foul smelling, offensive discharge from the nostrils should arouse a suspicion that screw worms might be present.

A number of cases of human myiasis caused by *C. macellaria* have been reported from different parts of the United States, and Central and South America, and in but a few instances does the patient recall being attacked by flies. In a few cases it has been claimed that a fly had dashed into the nose while the victim was awake and moving about, but he was unaware that any eggs had been deposited. It is more than likely that in such cases a fly dashing at the nostrils was simply a coincidence and merely recalled on account of the worms being present in the nose and the patient being at a loss to account for the presence. The chances are a thousand to one that the fly he recalled, or imagined as trying to dash into the nose was innocent of depositing the eggs, which were probably those of another fly, deposited without knowledge of the person attacked. An imaginative patient could readily recall at any time the annoyance caused by a fly buzzing about his head.

A mass of 100 eggs of this fly measures about 4 mm. in diameter, or about the size of a small pea. Such being the case it seems highly improbable to any one who has made many observations on this fly and who is familiar with their egg laying habits and the size of the egg mass, that any normal person and especially any one having the nasal passages clear and being in the habit of breathing through the nostrils, could have a mass of eggs in the nostrils until they hatch without being aware of the presence of a foreign substance, except under certain conditions.

It is the opinion of the writer that infestation takes place in the nose under one of the following conditions: 1. A person goes to sleep in the late afternoon or early evening, and sleeps all night; the eggs are deposited in the early part of the evening and have a chance to hatch so that the young larvae ascend into the nostrils before the sleeper awakes in the morning. 2. During the day time a person who is intoxicated may lie down out of doors and remain in a drunken stupor for a number of hours, giving the larvae opportunity to hatch either while he is still in the stupor, or while the after effects of the intoxication on his head prevent the discovery of the eggs in his nose until after they have hatched. 3. An individual that has just had an attack of nose bleed and had a blood clot still remaining in the nares might very readily have a mass of eggs in the clot without being aware of their presence until after they had hatched. 4. A person afflicted with leprosy or any other disease causing anesthesia of the nasal

mucous membranes could very easily have eggs deposited in the nose while asleep and not know of their presence until they had hatched and the larvae had burrowed into sound tissue and caused pain. In cases where several hundred screw worms are found in the nose it is very evident that the victim was asleep, and the fly was unmolested for some time while depositing the eggs.

The writer has been informed that in the interior and remoter parts of Panama, it is not uncommon to find among the natives or Indians cases of nasal myiasis which terminate fatally. A large percentage of these cases have become infested after the individual had visited some town or village, drank heavily, and started for his home in a state of intoxication. The patient has a number of miles to travel on foot, horseback, or in a cayuca. The liquor making him drowsy he lay down in some shady place to sleep, and having a bloody surface in the nose or suffering from a nasal discharge he became a good subject for infestation.

Screw worm infestation is frequently in the ears, although records seem to show aural myiasis is somewhat less frequent than nasal myiasis. Babies and other persons that are somewhat defenseless, and whose ears are discharging, or are neglected and allowed to become dirty and emit an odor, even though sometimes very slight, are the ones that usually become infested. In these cases if the worms are not detected at an early stage they penetrate into the middle and inner ear, causing considerable suffering and sometimes death.

Infestation of the genitalia takes place occasionally. This usually happens among naked children, though it sometimes occurs in old people, who through senility or other causes, do not keep themselves properly protected with clothing at all times. All open wounds, sores, ulcers, and abrasions of the skin in man if left unprotected by dressings or clothing also prove to be good places for the female of this fly to deposit her eggs. The smell of blood in a fresh wound as well as any suppurating sore serves as an attraction. As a matter of fact, this species seems to be greatly attracted by any animal odor and will deposit its eggs in most any place on either man or animal whenever a favorable opportunity presents itself.

A normal umbilicus is sometimes selected as a place for oviposition. A case of umbilical myiasis was encountered at the Ancon dispensary on January 10, 1916, when a white Spanish laborer came to complain of soreness in the umbilicus. Dr. S. L. Van Valsah, formerly of this hospital, examined the man and found in the umbilicus three fly larvae which he extracted. He was kind enough to send both the larvae and patient to the laboratory for me to examine. The patient was a clean, well kept man of middle age, and although the umbilicus was quite deep and nearly closed there was no apparent odor emanating. It had

a very red and irritated appearance and the man complained it was very sore and tender to touch, but the skin was not pierced and there was no blood showing. He stated that for several weeks he had been one of a gang of men engaged in cutting grass and bushes, and clearing land at Corozal. He had finished with this work on December 31, 1915. The following day, January 1, 1916, he felt something "molesting" him, as he termed it, in the umbilicus which gradually increased until the soreness caused him to visit the dispensary on January 10.

This man claimed that he lived in a screened house at Balboa; that he always wore a shirt while working; that he had not lain down to sleep during the day time; and also that he had never observed any fly alighting on him anywhere near the umbilicus, so that it remains a mystery as to when he became infested. Very probably he had either laid down and fallen asleep during the day time and did not care to acknowledge it, or a fly had entered his quarters either through a hole in the screening, or through a door which had been left open. Many of the Spanish laborers while at work wear but a light undershirt with no overshirt. This might have been torn or loose enough to allow a fly to reach the umbilicus while he was asleep. At any rate, infestation had taken place without his knowledge and undoubtedly while he was asleep.

Two of these larvae were rather small, but the third one was large and mature. They were bred out and proved to be *C. macellaria*. Evidently these larvae had been in the umbilicus for nine days, living on the exfoliated skin debris, perspiration, and such serum as possibly exuded from the tiny scratches made by the head hooks of the larvae. In this case there was no blood, or suppurating or raw surface to attract the fly. The only attraction was probably the odor of living flesh, or some odor that might have been thrown off from the umbilicus when the man while working became warm and perspiring. It is the opinion of the writer that an annual survey of all the towns and settlements throughout the Republic of Panama would disclose a surprising number of deaths due to screw worm infestation, either as a principal or contributory cause.

#### ATTACKS ON ANIMALS

Besides man nearly all kinds of domestic animals, and some of the wild animals are subject to attacks from this fly. It has been recently discovered that this fly will deposit its eggs in the nostrils of perfectly healthy dogs. Dr. H. C. Clark, pathologist at this laboratory, informed me that he had examined a dog a few months previous that had been infested in this manner. This dog was a male deer hound and one of a pack owned by a hunting club at Ancon. The pack had

been taken to the Province of Chiriqui on a hunting trip and the dog became infested in the nostrils while there. After doing considerable damage by eating through the tissues into the mouth, the maggots were all removed and the dog saved.

When brought back to Ancon, a few weeks later, the dog was brought to the laboratory and examined by Dr. Clark. The worms had caused a loss of bones in the upper right half of the mouth and nose, loss of teeth in the upper right jaw, and partial or complete loss of smell. The health was recovered in other respects. The dog was of no further use in hunting, as the destruction of the sense of smell incapacitated him for following a trail. The screw worm may be classed as an important enemy of dogs on the Isthmus, not alone owing to the actual amount of tissue it destroys, but also on account of giving a favorable field for micrococcus infection which often follows attacks of myiasis and causes death.

Cats lick and clean all wounds that they can reach so persistently that larvae seldom have any chance to live in a lesion, but one cat has been observed that had two full grown screw worms in an open wound at the base of the skull just back of the ears. In this location it was impossible for the cat either to lick them with her tongue, or to remove them by rubbing with her paws. These worms have also been found in neglected spur wounds on fighting cocks. It is not known whether this is a common occurrence or not but one case was noted personally in the city of Panama.

Three tame deer that were kept in a yard at the laboratory a short time ago all became infested from very insignificant wounds. One male had worms in a wound near the base of the horns which in the beginning was nothing but a small place where the skin had become chafed and broken by a rope tied about the horns. The second one become infested in a wound on the hind leg near the knee which was originally a small nail wound. The outer opening in the skin remained very small, but the cavity beneath was quite deep, reached to the bone and followed along side of it for a short distance down the leg. Fifty-two larvae were removed from this wound. The third deer acquired maggots in a small wound on the nose caused by running against the fence.

#### EMERGENCE OF LARVAE WHEN BURIED IN THE GROUND

It is manifest that when a horse, cow, steer, or other animal dies and is left for a few hours before being disposed of, many eggs of this fly are deposited in the mouth, nose and other cavities. If burial is the method of disposal and is delayed beyond the time required for the eggs to hatch, the cavities will contain many young larvae that



will be buried with the cadaver. Even if the eggs are not hatched before burial their hatching is delayed but little, and the young larvae emerge as readily under the ground as on the surface.

After a cadaver is interred decomposition takes place somewhat more slowly than when it is exposed to the open air. This delay combined with the fact that the ground absorbs a large amount of the gases thrown off enables the larvae to live in the cavities, and to find a sufficient supply of oxygen to insure their reaching maturity.

In order to investigate the depth at which the larvae may be buried and still live, develop and emerge from the surface as adults, seventy-five larvae about half matured were placed in a wide-mouth bottle containing a piece of fresh meat. The bottle was left unstoppered and placed at the bottom of a box about five inches square and three feet deep. A mixture of clay and sand was placed on top of the bottle to the depth of two and a half feet. This earth was tamped to make it as compact as undisturbed ground would be. A wire screen cover was then fastened securely over the open end of the box. The box with the closed end containing the larvae downward was set in the ground, the earth was replaced around the box and packed tightly to equalize inside temperature, moisture, etc., a few inches of the box and the screen cover projected above the surface of the ground, and was inspected each day thereafter for adult flies.

Ten days following the burial of the larvae the first adult flies were found in the cage. They continued to emerge up to the fourteenth day, and a total of forty-two emerged during the four days. This shows that 56 per cent. of the buried larvae lived to complete their metamorphosis and reach the open air as adults. Eighty-four per cent. of the number that emerged were females.

When the carcass of a dead animal is buried, it is seldom that it is covered with more than two and a half feet of earth; while 56 per cent. of the larvae buried with the carcass emerge at this depth, the percentage that emerges when the carcass is buried at lesser depth must be proportionately greater.

#### TRANSMISSION OF DISEASE BY THE FLY

Up to the present no positive proof has been found that will serve to incriminate the species as a disease-transmitting agent. However, work along this line is advisable, especially as regards the transmission of anthrax among cattle. When an animal dies of anthrax a thin blood stained fluid is usually sprayed from the mouth and nostrils. If in a pasture, the animal is generally stretched out on the ground, and when dying the ground in front of the head is sprayed with this liquid and the face around the nose and mouth covered with it. Cattle

dying of anthrax seem to bloat very quickly and in some cases the odor of decomposition is noticeable shortly after death even while the bloody spray is still wet on the muzzle of the animal, or on the grass in front of it.

In localities where the screw worm flies are numerous they are attracted to an animal succumbing to anthrax very soon after death has occurred. In such cases they are found either feeding on the discharged fluids on the ground or face of the animal, or are busy depositing their eggs about the mouth, nose, anus, vulva or other place where there is sufficient discharge to produce a moist surface.

In Panama the buzzards locate the body of an animal soon after death and after a few of these scavengers start feeding on a carcass it presents even better opportunities for the flies.

In April, 1916, the writer viewed the carcasses of three steers that had died of anthrax in a pasture near Colon. They had been dead only a few hours but had begun to bloat and a strong odor of decomposition was emanating from them. A veritable swarm of screw worm flies was feeding and ovipositing on each carcass, although they were nearly a mile apart. When these flies either feed or oviposit on a carcass the feet and proboscis must necessarily become contaminated and in my opinion they are capable of infecting any animal that they may visit shortly after; that is, providing the animal happens to have a fresh brand mark that is unhealed, cuts from barbed wire, horn wounds, or any skin abrasions.

It is claimed that the anthrax bacilli will survive in the ground for several years and that even if all cattle are removed from a pasture that has become badly infected and it is left empty for several years, the infection may be still in the ground. If cattle are pastured over this ground even after five or six years a fresh epidemic is liable to break out. If the *Bacillus anthracis* is able to survive the rays of the tropical sun in the soil of Panama for several years it is certainly able to live on the feet and proboscis of the screw worm fly for a few hours or even days. It is plausible to believe that this fly may be one of the principal carrying agents in tropical and subtropical countries and it is hoped that observations may be carried out to test this theory of transmission.

#### BREEDING OUT LARVAE FROM CASES OF MYIASIS

Although the screw worm fly is the principal culprit it is known that other flies have the habit of depositing their eggs or living larvae in open wounds or on exposed parts of the body. It is to be deplored that in a great many cases of human myiasis the larvæ are never identified or bred out to ascertain whether they are really *C. macellaria* or some other variety of fly. It is therefore suggested to physicians

called to attend a case of myiasis, that before washing the wound with any solution they remove specimens of the larvae from the lesion by means of forceps, with as little injury as possible, and place them in a glass jar containing damp sand and a piece of meat or decayed vegetable. The jar should be covered with a piece of muslin drawn tightly over the top and fastened with string or a broad elastic band. Beyond noting if more food is needed nothing else is necessary except to watch for the emergence of the adult flies. When they appear a few drops of chloroform may be poured on the muslin top which should then be covered with a piece of pasteboard or other flat object to retain the chloroform vapor in the jar. After exposure to this for a few minutes the flies may be removed and examined.

If this procedure could be carried out in all cases of cutaneous myiasis it might incriminate other flies on the Canal Zone, hitherto unsuspected, of having the same propensity for breeding in living flesh. *C. macellaria* is easily the principal offender in cases of nasal myiasis.

#### PREVENTIVE AND CONTROL MEASURES

Tests which are detailed in the complete paper were made with different drugs and chemicals to determine their respective lethal effects on the screw worm. From twenty to twenty-five worms, all of which were approximately mature, were used in testing each substance. The agents giving the most satisfactory lethal action were fat solvents which readily penetrated and dissolved the fatty tissue of the larvae.

Owing both to the great diversity of the breeding habits of this fly, and to the peculiar conditions existing in Panama, but little can be said in regard to its control. In caring for animals with infested wounds all open lesions may be sprayed with chloroform or carbon tetrachlorid to remove the maggots. Both of these have proved efficacious.

Carbon tetrachlorid is as fatal to the maggots as chloroform if not more so, it is equal in penetrating power, does not evaporate any more readily, produces no more irritation to the tissues, does not retard healing any longer, and is much cheaper. Carbon tetrachlorid does not attract the flies by its odor as the carbon bisulphide is said to do, and it also lacks the inflammability of the latter.

In deep punctured wounds it may be best to spray with glycerine first to cause the maggots to become active and approach the outer opening of the wound. They may then be sprayed with carbon tetrachlorid to destroy them. If one of the lethal fat solvents is injected in a deep wound in an undiluted state the larvae are apt to be killed before they are able to leave the wound, and remain as a foreign body causing suppuration. After a wound on an animal has been

cleaned of all screw worms it should be dressed with one of the repellent agents to keep the flies from depositing more eggs in the wound. Pine tar is a good repellent.

An excellent protective dressing may also be made by mixing equal parts of beeswax, fish oil, and carbon tetrachlorid, working in enough vaselin to give it the proper consistency. If all animal wounds, both those which are fresh and those from which the screw worms have been removed, are painted with this mixture it will prevent the flies from depositing their eggs and save the cattle from damage as well as reduce the number of the flies.

All fresh meat should be screened to prevent it from becoming blown and if necessary the screen may be reinforced with cheese cloth.

Lastly, all parties camping in the jungle should sleep under mosquito netting. This especially is necessary for persons having a nose bleed or catarrhal condition. And it should be remembered that it is of more vital importance to use the mosquito netting while taking siestas during the day than at night, as far as protection against this fly is concerned. A number of people who would use a netting at night as a protection against mosquitoes would scorn to sleep under it during the day time, but it must be remembered that the screw worm fly apparently deposits her eggs during the daylight hours, or at least before it gets very dark.